Evaluation of Web Based Behavioral Interventions using Spoken Tutorials

[a]Kiran L. N. Eranki, [b]Kannan M. Moudgalya

IDP Educational Technology, IIT Bombay, Powai, Mumbai 400 076, India.
email: [a]erankikiran@iitb.ac.in, [b]kannan@iitb.ac.in

Abstract— The clumsy and the inconsistent web interface of spoken-tutorial.org impedes its use by creators, reviewers, users and workshop organisers. Based on the analytics, such as the traversal paths taken by the learner to access the content and the duration of time spent, and the informal feedback, we have created a new integrated interface for the spoken tutorials. Cluster analysis of usability studies conducted on 82 engineering college students has confirmed that the new interface addresses the shortcomings of the old interface. The results also indicate that computer experience is a key factor that influences their preference towards e-learning interfaces as investigated through learner behavioral interventions.

Keywords— Spoken-tutorial, usability, e-learning, behavioral interventions

I. Introduction

Collaborative learning, contribution and review are not just solitary pursuits, but collaborative activities intervened with each other into the social life of communities. Web based e-learning interfaces are growing rapidly with advances in ubiquitous [1] and collaborative learning models. In this pursuit, we examine the Spoken-tutorial.org [2] e-learning interface to intervene the behaviour interventions of its learners. We also address the shortcomings and the measures to restructure such collaborative learning interfaces. Learners have several preferences that greatly influence their learning patterns and are different from each other [3]. Web based e-learning interfaces have become increasingly popular in educational settings. Due to such popularity, students with different backgrounds, knowledge, and skills seem to have a personal preference on the content available. The preferences of the learner [4] contribute to effective design and analysis of web interfaces. In addition to preferences, human factors such as learning styles, gender and prior knowledge are also important. Among them, learning style provides an insight on differences in information representation and processing among the learners [5], which is also widely studied in the area of web interfaces. Pask and Scott [6] have classified learners based on behavior into Field Dependent/Independent. Such interventions suggest the role of cognitive styles in the design of web-based interfaces. Ford and Miller [7] have also supported the classification of Holist/Serialist learners and their potential in web based e-learning interfaces.

The paper is structured as follows: Section 2 presents the relevance of web-based e-learning interfaces by analysing the problems of existing research in the field. Section 3 describes the methodology used to conduct the study and to analyse the resulting data. Subsequently, the results and conclusions of the study are presented.

II. Relevance of Web-Based e-learning interfaces

Web-based e-learning interfaces (WBeI) provide a flexible self-paced e-learning environment for students to learn and teachers to teach in an non-linear fashion [8]. To improve and to increase information availability for students, short segment videos of 10-15min duration presented using WBeI seem to be very effective [9]. Spoken-tutorial.org is one such WBeI to teach various FOSS courses through video screencast by an expert using different navigational tools [10], [11]. There is a need to examine the behavioral interventions of the learners based on cognitive styles. As these reflect the information processing habits, mode of perceiving, thinking, remembering, and problem solving become important [12]. Students with field dependent behavior [13] rely more on classroom notes and resources than independent learners, who tend to use the navigation keys more optimally. Some of these behavior interventions provide clues to designers and content developers to visualize the preferences of the learners in WBeI. The target of current study has a large number of users with a potential also to get a lot of feedback. In view of this, quantitative studies are possible and are also perhaps more appropriate. In this paper, we apply a data mining approach to investigate the influences of human characteristics on users preferences, while using WBeI.

III. Spoken Tutorials

In this section, we will give a brief overview of source of difficulties in creating a WBeI in the spoken tutorial project. We will also flag the resulting shortcomings in using the WBeI by the collaborators of this project.

A. Evolution and Current Status

A spoken tutorial is a screencast with a running commentary. It can be used to explain a session. If suitably created, even a novice can easily use a software. A ten minute spoken tutorial can have more than about one hundred screen transitions. As a result, the screencast is the most effective way to create such an instructional material, compared to all other methods, for example, creating a pdf file with screen shots manually inserted in.

Dubbing of only the audio can be done at a very small effort, if the original is properly created [10]. This makes

IEEE computer society

spoken tutorials accessible even to people who are weak in English. The use of English screen shots ensure that these learners do not lose the employability.

In order to scale up the use of these tutorials, the tutorials should be made suitable for self learning. A check by a novice has been used to address this requirement. Self learning material could be used to learn technologies and to address the digital divide.

Covering all FOSS systems and also the vast field of digital divide topics is a Herculean task. The only way to achieve any meaningful progress in this effort is to resort to collaborative content creation. Outline, script, novice check, recording, review, translation of the script and dubbing are some of the important steps while creating spoken tutorials. These tasks can be carried out by different people from different backgrounds and different skill sets, provided we have a well designed WBeI. Some of the issues currently tackled in the creation of spoken tutorial are summarised in [14].

The spoken tutorial project has funding from the Indian Government to create content. One of the mandates of this activity is to ensure that many people should contribute to content generation and also to benefit from the resulting honoraria. In order to provide easy access for everyone, Free and Open Source Software (FOSS) systems were chosen for creating the content. In order that the resulting content is useful to everyone, the focus of work is restricted to FOSS systems.

The mandate of the spoken tutorial project is also to train a large number of students on various FOSS systems. This project has been conducting Spoken tutorial based Education and Learning through Free (SELF) FOSS Study Workshops since June 2011. These workshops are of two hour duration and are offered free of cost to college students. A student volunteer can organise these workshops - no domain expert is required. Based on the performance in a post workshop test, the participants are given a certificate. About 2,100 workshops have been conducted so far since June 2011. At present, about 200 workshops are conducted every month. These workshops train a minimum of 30 students. The average success rate of the students in the post-workshop test is 85%, compared to the about 20% success rate in the pre-workshop test. These workshops are at present conducted on the following FOSS systems: Linux, Python, Scilab, LATEX, LibreOffice and PHP-MySQL.

More than 10,000 students have registered in our website, as they have to take pre and post workshop tests online. Many of these students have participated on SELF workshops on two or more FOSS systems. The number of page loads from the website spoken-tutorial.org is now more than 2,000 per day. It has been growing at a rate of more than 50% in the last three quarters. Fig. 1 shows the number of page loads on http://spoken-tutorial.org during the last 12 months.
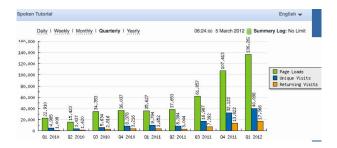

Fig. 1. Snapshot view of http://www.spoken-tutorial.org page loads as on 5th March 2012.

B. Shortcomings of WBeI and User Feedback

It is important to realise that the activities discussed in the previous section evolved over time. All of them were not understood at the beginning. The WBeI evolved over time, accommodating all the requirements, as they developed. For example, when the spoken tutorial activity started, there was not even a mention of *novice check*. Similarly the constraints to be enforced on the tutorial so as to enable easy dubbing was also understood only later on. The SELF FOSS Study Workshops mentioned in the previous section also came into effect only in the last three quarters. The fact that a large number of student volunteers have to be given necessary information to conduct the SELF workshops was not known when the project started.

Because of the incremental development, the WBeI turned out to be inconsistent across different components and different FOSS systems. Some information is repeated in more than one page, some times providing completely different messages. The viewers had to navigate through many pages before they located the information they wanted.

The creators of the original spoken tutorials did not know on what systems they could create new spoken tutorials. Language enthusiasts could not find out the extent of dubbing in their language. As a result, dubbing work suffered.

Some students who underwent the SELF workshop and pre and post workshop tests requested that the WBeI be improved. Some of them are listed below:

"i think language option can be shown along with tutorial names, it's many clicks" - 7/17/2011 12:53:43 G Vigneshwaran TAM-001-0016 SAS-TRA University Male, Linux

"study plan link gives a wrong video page and please check link missing" - 7/18/2011 10:27:04 solanki ramesh 9220818200 VESIT Male solanki-ram123@gmail.com, scilab

The clumsy and inconsistent interface was found to be difficult to use by the creators of the content as well. As there was no provision given for uploading all the associated material, such as assignments, slides, computer programs, etc., some were getting left out. The content management team had to put in a lot of time to create links to all the uploaded information.

Fig. 2. Spoken-Tutorial Old Interface- Study Plan based

Fig. 4. Spoken-tutorial Collaborative Content Management page

Thus the WBeI turned out to be difficult to use for content creators, content managers, self learners and workshop organisers. A snapshot the WBeI is given in Fig. 2.

IV. RESEARCH QUESTIONS

It was decided to take up the WBeI of the spoken tutorial website as the candidate to understand the behavioral interventions of the learner. The idea was to develop a new WBeI using the feedback of all types of users of the old WBeI. A comparative study of these two interfaces can throw light on the behavior patterns. As a beneficial side effect, it would also help create a lot more useful interface.

The research questions examined in this study are:

1) Does behavior interventions help in understanding the learners preferences while using a WBeI?.
2) What is the role of learner preferences in designing collaborative WBeI?.

Thus, usability and user preferences are the two things that we planned to understand through this study.

V. NEW WBeI FOR SPOKEN-TUTORIAL.ORG

We discuss below the shortcomings of the old WBeI of spoken-tutorial.org and the approach taken by us to develop a new interface:

1) As the business logic evolved over a period of time, the implementation turned out to be bad. The old WBeI was based on Drupal 6 [15], a FOSS content management system. Nevertheless, as Drupal does not have a good business logic, the problems worsened. But as the processes are well understood at the beginning of this study, it is perhaps possible to develop a consistent interface from scratch.
2) It was difficult to integrate the Media Wiki page that stored the script with the rest of Drupal pages. This resulted in duplication of content. Moreover, it became difficult to present all the associated material of a spoken tutorial in one place. We can integrate the two if the code is developed completely in PHP.

3) Very little automation was used in the old WBeI. This resulted in inconsistent naming conventions while simultaneously increasing the work of the content management team. If the interface is developed in PHP, however, one can automate most of the processes.

Because of these reasons, it was decided to redevelop the interface using PHP. Many other features of the old interface, such as user databases and blogs were retained in Drupal. As Drupal itself is written using PHP, these two could coexist. There is also a possibility of creating specialised modules to convert the PHP code into Drupal modules in the future. The architecture of the new WBeI is given in Fig. 3.

MySQL has been used as back-end database supported by PHP scripting. In order to automate the day-to-day tasks at spoken-tutorial, PHP and Java scripting languages were used extensively to design and develop an automated content management system. New interface takes care of automated content validation and version control. It also provides stringent policies on data backup and disaster recovery.

The interface used for the creators to upload their content is shown in Fig. 4. The same interface serves the reviewers and the administration team.

The interface seen by the learners is shown in Fig. 5. This allows the learners to choose spoken tutorials by FOSS or language or both. One can see the languages in which a particular FOSS tutorial is available. One can also see what all tutorials are available in a particular language.

Once a particular spoken tutorial is selected, the display interface provides links to all associated material of a spoken tutorial in one place, as shown in Fig. 6. In addition to helping the learners, this facility is most useful to the administration team, as they can easily figure out if any associated material is missing. Differences between the old and the new WBeI are summarised in Table I.
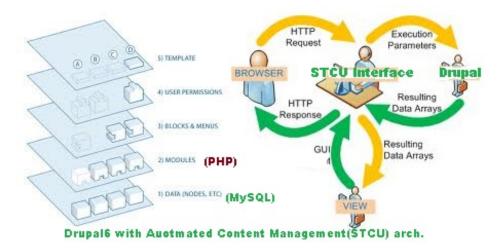
Fig. 3. Drupal 6 with Content Management Architecture

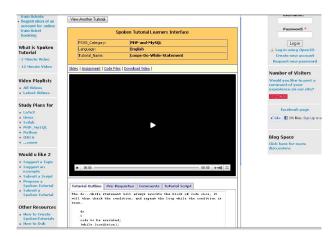Fig. 5. Spoken-tutorial new interface - FOSS search based

Fig. 6. spoken-tutorial new interface: All components are shown in a single page

TABLE I
DIFFERENCES BETWEEN OLD AND NEW WBEI INTERFACES

Features	Old	New
Interface	Multi-Page access	Single page
Search	Static Links	Search Filters
Components distribution	Multi-page	Single page
Alpha index	Study plan	FOSS Search
Layout Colors	Multi-color	Single color
Buttons /Menus	Static no drop-downs	Dynamic drop-down menu

TABLE II
SAMPLE USED IN THE COMPARATIVE STUDY

College	FOSS	M	F
Allahabad University	Linux	18	3
Allahabad University	Spoken tut. tech.	2	1
Paavai engg. college, Anna univ.	LATEX	14	3
RAIT, Nerul, Mumbai Univ.	PHP	17	24

VI. A COMPARATIVE STUDY OF THE TWO WBEI

In this section, we compare the old and new WBeI. We first present the sample used for this study. We present the questionnaire and the process used in this study. We briefly summarise the method used to analyse the resulting data.

A. Sample and Process

Students of different engineering disciplines from three colleges belonging to three universities participated in this study. All of them had a basic knowledge of computing and Internet skills. A breakup of the sample is given in Table II. One can see that there were 51 males and 31 females amongst the participants.

The students were requested to go through two spoken tutorials from any FOSS system through the old WBeI at the beginning of the workshop session. They were required to answer the questionnaire given in Table III.

Sno	Questions
1	I think that I am able to use spoken-tutorial.org website to learn courses on FOSS(free open source software).
2	I found spoken-tutorial.org web interface easy to use and learn FOSS courses.
3	I think that i would need support of a technical person to use spoken-tutorial.org web interface to access the FOSS content.
4	I found the organization and content display of spoken-tutorial.org well integrated.
5	I found too much of inconsistency in terms of the content display, levels of organization to learn a FOSS course.
6	I would imagine that students who go through spoken-tutorial.org e-learning interface would be able to understand various FOSS courses very quickly.
7	I found learning a FOSS course through spoken-tutorial.org interface was very cumbersome to use.
8	I felt very confident while learning a FOSS course through spoken-tutorial.org interface.
9	I feel that one needs to learn a lot of things before one could learn a FOSS course provided in the spoken-tutorial.org.
10	I found resources such as forums and wiki very helpful in learning a new FOSS course at spoken-tutorial.org website.
11	I think spoken-tutorial.org website needs to be re-organized in terms of course content based on a pre-requisite to help students learn courses on FOSS.
12	I think learning a new FOSS through spoken-tutorial.org website is easy and comfortable than learning it by reading a FOSS textbook.
13	I found spoken-tutorial.org e-learning interface was complex to navigate and also shows too much of content.
14	I have found some accessibility issues while using spoken-tutorial.org website to learn a course on FOSS.
15	I found the content provided in wiki well organized to correlate with video tutorials presented in spoken-tutorial.org website while learning a new FOSS course.
16	I sometimes get lost because buttons/Links make me feel confused.
17	I would prefer to learn from a teacher/tutor than from this video tutorials to learn new FOSS course
18	I like the fact that it allowed me to learn a new FOSS course in any order.
19	I felt sufficiently well to learn a new FOSS Course without any instruction.
20	The Links provided in spoken-tutorial.org interface are easy to understand and navigate while learning a new FOSS course
21	You prefer to watch content on FOSS using:
	[Single Page]
	[Multi-Page]
	[Static Button/ No Drop downs]
	[Dynamic Button/Drop downs]
	[Std. Color]—[Multi-Color]
	[FOSS + Language Filter Search]
	[Study Plan based Search]

Then they proceeded to do the SELF workshop as usual, namely, take the pre-workshop test and then participate in the workshop. After spending the usual time of two hours on the workshop, they were required to access two more spoken tutorials through the new WBeI and to fill the same questionnaire once again.

About a half of them went through the old interface first and then the new interface. The rest followed the reverse order: the new and then the old. This is done to reduce the order index effect.

As mentioned earlier, the new interface has search filters, hyperlinks and various components of each tutorial organized within a single page. As a result, a fewer number of links and buttons are required to navigate. The old interface, on the other hand, is organized in multiple pages. As a result, one needed to navigate for each and every component of the spoken tutorial, though the content remained the same in both the interfaces. The differences among the two interfaces has been shown in Table I.

B. Systematic Usability Scale (SUS) Questionnaire

All students were asked to fill out SUS questionnaire so that their perceptions on the use of Spoken tutorial.org interface can be identified. This instrument was chosen to predict cognitive and affective data [16]. The standard questionnaire was modified to suit the current study. The reliability of the questionnaire was found to be acceptable ($\alpha = 0.88$). The questionnaire consisted of 20 questions related to student preferences on WBeI. All the participants were asked to rate the questions based on a 5 pt Likert scale (strongly agree, agree, neutral, disagree, strongly disagree).

Based on demographic details gathered using Pre-test questionnaire, participants were grouped as 'experts' and 'novices' based on the number of hours spent using software and computers. Learner preferences were identified through the choice of features selected using SUS questionnaire. By using the features indicated by the participants, we have applied data mining approach to classify and cluster the participants. We have found five conspicuous feature sets, namely: (a) Layout-Colors (b) Search (c) Interface (d) Links/Buttons/Menus (e) Alphabetical Index.

C. Data Mining

Feature sets are classified and clustered by using K-modes algorithm, considering its wide application to cluster objects with similar features and also based on its computational efficiency [17]. The weight of the cluster C is given by

$$W(C) = \frac{1}{2} \sum_{k=1}^{K} \sum_{C(i)=k} \sum_{C(j)=k} \|x_i - x_j\|^2$$

$$= \sum_{k=1}^{K} N_k \sum_{C(i)=k} \|x_i - m_k\|^2$$

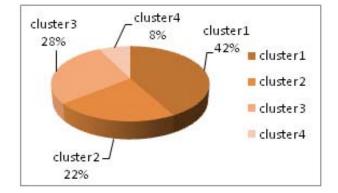| Features	C1	C2	C3	C4
Interface	Single page	Multi-page	Single page	Multi-page
Layout	Std. Color	Multi-Color	Multi-Color	Multi-Color
Alpha-Index	Study Plan in-dex	FOSS Search	FOSS Search	Study Plan index
Search	Search filter	Static Links	Search filter	Static Links
Buttons /Menu	Dynamic, drop downs	Static, no drop down	Dynamic, drop down	Dynamic drop downs

Fig. 7.   No. of users in each cluster

where, x_i, x_j are observations, m_k is the mean vector of cluster k and N_k is the number of observations in k^{th} cluster.

This algorithm works on categorical data. It replaces the means of clusters with modes and updates modes by using a frequency of occurrence.

VII. RESULTS AND DISCUSSIONS

Depending on the learner preference of the WBeI, feature sets are clustered as shown in Table IV. For example, cluster 1 (C1) groups the users who prefer single page interface, standard colour layout, study plan based indexing, search filters and dynamic drop down menus. As explained in SUS questionnaire, C1 comprises novices and C4 consists of experts.

From Fig. 7, we can find that C1 has more number of users and cluster 4 being the least popular. C1 and C3 seem to have similar features except the alphabetical index and the layout-color preference of the web-page. C1 has more number of participants than other clusters. The members of C1 preferred a single page with standard color, study plan based indexing with search filter having dynamic buttons and drop-down menus (N=34, 42%). As C4, which denotes multi-page layouts, multicolor based search using static links and static buttons with no-drop down menus, is the smallest in size, we conclude that these features are least preferred by the learners. These results are comparable to

the cognitive load theory [18], which suggests that the focus of any learning should be the content itself. In other words, interfaces must be designed to minimize cognitive load.

Application of standard color layouts can actually help in focused learning to better concentrate on the instructions. On the other hand, multiple-color layouts with effects promote distraction and unnecessary clutter to the user's mind to enhance cognitive load and to dissipate mental energy. This may explain why most users prefer the single color scheme, instead of multiple color layouts with effects. This is confirmed by C4 having the least number of users (N=6, 8%).

We also see that the users in C4 prefer multi-page layouts and dynamic buttons. This combination results in a pleasant visual display. All the six participants of C4 are women. A noticeable difference between females and males appears to differ in terms of preference to presenting information [19]. This also explains the reason why female users prefer in-teractive WBeI with appealing visual displays, as illustrated by their preferences showed in C4.

Arrangement of content by study plan based index as shown in Fig. 2 also showed statistically significant value (F(3,82)=4.16, p<0.05) in C1. This is not surprising, as a novice prefers a study plan based index rather than a FOSS search based index. In other words, a beginner who lacks computer experience prefers to go by the name of a tutorial rather than using a keyword based search.

The influence of computer experience, gender, study-level on WBeI has been analysed using the Analysis of Variance (ANOVA). We found that the computer experience has the largest statistically significant influence (F(3,82)=4.36, p<0.05). It confirms the earlier classification of clusters C1 and C4 as those representing novices and experts, respectively.

Let us next move on to layouts. The participants in C1 prefer standard color layouts. This choice denotes less anxiety [20]. This is in agreement with the characteristics of beginners, who would want to follow a simple method.

Fig. 9 shows a distribution of computer expertise feature in different clusters. It is also statistically significant for both novices (N=26,C1) and experts (N=13,C3). As all the participants in C4 are experts, it is natural that they prefer multi-page layout, as this may denote complexity [21]. On the other hand, novices like single page search based interfaces.

The effect of computer experience on users' preferences to dynamic-drop down menus/static buttons (F(3,82)=11.67, p>0.001) also shows statistical significance, where experts seem to prefer dynamic drop-down menus, and novices prefer static-drop down menus. Considering the novices don't have any formal training or experience to handle such interfaces, this is expected.

SUS scale scores show an acceptable usability score of p=72.1% for the old interface and p=81.3% for the new interface. As both are greater than 67%, both interfaces seem to be liked by the learners. But as the new interface
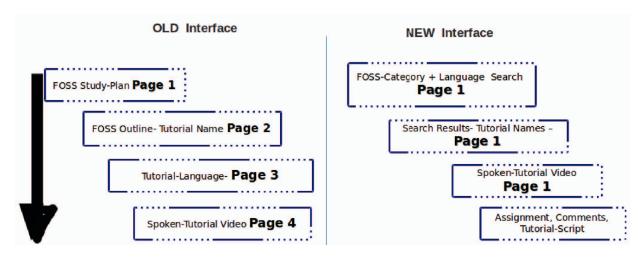
Fig. 8. Traversal paths taken by the learner while accessing the spoken-tutorial.org interface
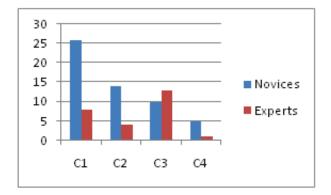

Fig. 9. Cluster Distribution based on Computer Exp.

has a larger score, it is liked more. Traversal paths taken by all the learners while using old and new interfaces has been shown in Fig. 8. Based on the cluster analysis, we have found the modified user interface to be in line with the preferences of the users of spoken tutorials.

We have also received informal feedback from the content management team and the administrators about the effectiveness of the new WBeI. As the number of people in this group is small, it is not possible to present a quantitative analysis. This group feels that the new interface reduces their work by 90%.

VIII. CONCLUSIONS

The study presented in this paper applied a data mining approach to discover relationships between behavioral interventions and preferences of learners while using spoken tutorial WBeI. We were also able to resolve the drawbacks found in old interface through this study. New interface was built to support automation of all the requirements of the spoken tutorial project. This has also contributed to generation of effective WBeI. We hope that this is the first

step towards the crowd sourced collaborative spoken tutorial generation similar to Wikipedia.

Cluster analysis shows a diverse groups of learners based on their varied preferences across clusters. Computer experience seem to influence all other preferences. More specifically, experts favor multi-page dynamic buttons and drop down menus, while novices prefer single page, dynamic buttons and drop down menus. These results are in agreement with the previous findings.

Although the new interface comes out to be better than the old, the difference is small. This is possibly because the participants did not explore all the features available in the new interface. Locating all of them in the old interface would have been a lot more time consuming and possibly difficult. A more detailed study involving these features could prefer the new interface even more.

The new interface can easily accommodate new features, such as supporting the organisers of the SELF workshops and feedback. It can also help in crowd sourced generation of content, such as additional examples and questions.

We strongly believe that the new interface would release a lot more time for productive uses, such as, original spoken tutorial creation, dubbing and organization of more workshops.

REFERENCES

[1] C. C. Vo, T. Torabi, and W. Loke. Towards context-aware task recommendation. In *Joint Conference on Pervasive Computing (JCPC)*, pages 289–292, 3-5 December 2009.
[2] K. M. Moudgalya. Spoken tutorials. In *Technology for Education(T4E)*, pages 17–23, August 2009.

[3] K. L. N. Eranki and K. M. Moudgalya. Evaluation of student perceptions and interests using spoken tutorials in online courses. In *International Conference on Advanced Learning Technologies*, ICALT 2012, Rome, Italy, 4-6 July, 2012. IEEE.

[4] A. Brooks and L. Scott. Constraints in CASE tools: results from curiosity driven research. In *Proceedings of the 2001 Australian Software Engineering Conference*, ASWEC 2001, Australia, 2001. IEEE.

[5] R. M. Felder and L. K. Sileverman. Learning and teaching styles in engineering education. *Engr. Education*, 78(7):674–681, 1988.

[6] G. Pask and B. C. E. Scott. Learning and teaching strategies in a transformation skill. *British Journal of Mahtematical and Statistical Psychology*, 24:205–229, 1971.

[7] N. Ford and D. Miller. Gender difference in internet perception and use. In *Electronic Library and Visual information Research. ELVIRA 3: Papers from the Third ELVIRA conference*, pages 87–100, 30 April - 2 May 1996.

[8] M. Bers. A constructionist approach to values through on-line narrative tools. In *Proceedings of International Conference for the Learning Sciences (ICLS 98)*, pages 49–55, 1999.

[9] T.S-Mahmood and D. Ponceleon. Learning video browsing behavior and its application in the generation of video previews. In *ACM Multimedia Conference*, pages 119–128, Oct 2001.

[10] K. M. Moudgalya. Spoken Tutorial: A Collaborative and Scalable Education Technology. *CSI Communications*, 35(6):10–12, September 2011. Available at http: //spoken-tutorial.org/CSI.pdf.

[11] K. M. Moudgalya. LaTeX training through spoken tutorials. *TUGboat*, 32(3):251–257, 2011.

[12] R. Paolucci. The effects cognitive style and knowledge structure on performance using a hypermedia learning system. *Journal of Educational Multimedia and Hypermedia*, 7(2/3):123–150, 1998.

[13] B. Hasan. The influence of specific computer experiences on computer self-eficacy beliefs. *Computers in Human Behavior*, 19:443–450, 2003.

[14] P. Gopal, N. Varkey, and K.M. Moudgalya. Visual maps for collaborative spoken tutorial development. In *Technology for Education, T4E 2012*, Hyderabad, 18-20 July 2012. IEEE.

[15] Drupal, http://www.drupal.org,Last seen on 5 March 2012.

[16] S. Feinberg and M. Murphy. Applying cognitive load theory to the design of web-based instruction. In *Proceedings of IEEE professional communication society, international professional communication conference and proceedings of the 18th annual ACM international conference on computer documentation: technology & teamwork*, pages 353–360, 2000.

[17] A. K. Jain and R. C. Dubes. *Algorithms for clustering data*. Prentice Hall, New York, 1988.

[18] J. Sweller, J. van Merrienboer, and F. Paas. Cognitive architecture and instructional design. *Educational Psychology Review*, 10:251–296, 1998.

[19] N. Ford and S. Y. Chen. Individual Differences, Hypermedia Navigation,and Learning: An Empirical Study. *Journal of Educational Multimedia and Hypermedia*, 9(4):281–311, 2000.

[20] J. J. Beckers and H. G. Schmidt. Computer experience and computer anxiety. *Computers in Human Behavior*, 19(6):785–797, 2003.

[21] D. Chua, D. Chen, and P. Wong. Computer anxiety and its correlates: a meta analysis. *Computers in Human Behavior*, 15(5):609–623, 1999.